

# **Ontology-Driven Knowledge Organization – Enhancing UDDI Web services in Korea Using Topic Maps\***

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Effective and efficient publishing and searching for Universal Description, Discovery and Integration (UDDI) Web services is important for the success of Web services. Traditional approaches such as index, thesaurus, and classification have historically dominated information representation and organization; however, they have some

**limitations. Ontology-driven knowledge organization [An ontology-driven knowledge organization approach] is considered one of keys to the next generation of knowledge management applications because ontology provides structure and meaning to data. This research examines how ontology-driven knowledge organization could provide benefits to current UDDI Web services.**

## **Introduction**

The term *ontology* is defined as “an explicit specification of a conceptualization” (Gruber, 1994) or “a set of types, properties, and relationship types” (Garshol, 2004). As a framework for knowledge organization, the potential of ontology, the needs of ontology, and the usefulness of ontology have received much attention in the semantic web community. In one sense, ontology has been expected to improve information retrieval as well as knowledge organization. However, there have not been many significant studies that demonstrate how ontology can be beneficial to practical areas such as knowledge management and Web services.

Web services, which aims at helping users to find service information available on the web no matter where they are, and agencies to improve efficiencies (Lurie, J. & Lurie, S., 2002), has been investigated employing different approaches and levels. UDDI, as a part of Web service, supports the discovery level of Web service (Peel, 2002a) based on three classification systems – Universal Standard Products and Services Codes (UNSPSC), North American Industry Classification System (NAICS), and International Organization for Standardization (ISO) 3166. UDDI allows service providers not only to register their Web services but also to find business partners by searching registered Web services.

This project, sponsored by the Korea National Computerization Agency, developed a Korean UDDI Web service classification system. Its purpose was to reflect Korea Web service environments, particularly those portions that are not in line with the UNSPSC classification system.

The purpose of this paper is to explore how ontology-based knowledge organization could improve current UDDI Web services. For this purpose, we first explain what ontology and topic maps are and explore what benefits ontology has for knowledge organization and information retrieval. Then, we present a case study to show potential benefits in solving the problems associated with current UDDI Web service in Korea.

There are a number of ontology languages and tools for constructing ontologies. However, in this paper, we chose topic maps as an ontology language because of its expressive power and more stable deployment compared to resource description framework (RDF)/Web Ontology Language (OWL). We employed LTM syntax in creating topic maps and "Omnigator" topic map browser to demonstrate what we developed.

## **Ontology and Topic Maps**

### ***Ontology***

The term ontology was coined in 1613 by Rudolf Gockel (Welty & Guarino, 2001) and has been used in various fields such as philosophy, computer science, library and information science. Ontology defines concepts in a specific area and their relationships; however, ontology is more than an agreed-on term. It has a set of well-defined constructs that can be leveraged to build structured knowledge. Although taxonomy enhances the semantics of terms in a vocabulary, ontology includes richer relationships among terms (Smith, 2004). Welty defined ontology as "a discipline of philosophy that deals with the subject of existence." In the context of knowledge sharing, Gruber uses the term ontology to mean a specification of a conceptualization (Gruber, 1993). Ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents (Gruber, 1993).

Ontologies are also not limited to conservative definitions - that is, definitions in the traditional logical sense, which only introduce terminology and do not add any knowledge about the world (Enderton, 1972). Ontologies can define the relationships among resources and find related resources. For example, a "lives at" link or "works for" link in ontology can be used to track these types of relationships and their corresponding values for listed individuals. Ontology is the framework of the semantic web, and permits intelligent navigation (Information Intelligence, 2004). For humans, ontologies enable better access to information and promote reuse and shared understanding; for computers, ontologies facilitate comprehension of information and more extensive processing (Ontology Engineering, n.d.).

## ***Topic Maps***

Topic maps are an ISO standard for describing knowledge structures and associating them with information resources. Topics maps are the equivalent of the traditional back-of-the book index in the world of electronic information (Pepper, 2002). Topic maps provide an approach that unites the best of several worlds, including those of traditional indexing, library science and knowledge representation, with advanced techniques of linking and addressing (Pepper, 2002). In fact, indexes, glossaries and thesauri are all ways of mapping the knowledge structures that exist implicitly in books and other sources of information (Pepper, 2002). Ruggels (1997) claims that "knowledge management covers three main knowledge activities: generation, codification, and transfer"; topic maps, then, can be regarded as the standard for codification that is the necessary prerequisite for the development of tools that assist in the generation and transfer of knowledge.

The main concepts of topic maps includes; 1) Topic, 2) Occurrences, and 3) Associations. Topic and associations are the roles of ontology and the concept of occurrence borrowed from topic maps (TopicMaps, 2000). There are many ontology languages such as Cmap, simple common logic, RDF/OWL, and Topic Maps. However, RDF/OW is a W3C standard and Topic Maps is an ISO standard. It will be very important to construct ontologies using standard syntax for better data interoperability and integration. The task force team under W3C (RDF/TM) is formed to ensure data interoperability between RDF/OWL and Topic Maps. They are not competing but pursue different approaches (Garshol, 2003).

## ***Topic***

A topic can be anything such as a concept or a person (Pepper, 2002). Pepper (2002) asserts that topic refers to the object or node in the topic map that represents the subject being referred to. For example, as operas, "Tosca," "Madame Butterfly," "Rome," "Italy," "Giacomo Puccini," and "Lucca" are topics. Assigning more than one name to a topic indicates that all the names refer to the same subject and the names are all synonyms (Garshol, 2004). Topic maps also allows different topics to have the same name, a feature that taxonomies and thesauri do not allow (Garshol, 2004). In practice, this is something that happens all the time, and so it is

important to support it within the IT system.

### ***Occurrences***

Pepper (2002) defines occurrences as follows: "A topic may be linked to one or more information resources that are deemed to be relevant to the topic in some way. Occurrences are like page numbers in a back-of-book index (Garshol, 2004). An occurrence shows where information about a subject can be found. Occurrences tie the topics to information resources that hold information about those topics. This is the inverse of the "subject" property in Dublin Core, which connects an object to related subjects (Garshol, 2004)

Occurrences have types and types of occurrences allow us to differentiate between different kinds of relationships to the information resource (Garshol, 2004). One can distinguish a biography from a portrait, a description from a tutorial, a video clip from a specification, and so on. This is a significant feature of topic maps because it provides an effective way to accomplish the second purpose of cataloging (Cutter, 1875), which is grouping related information as a search result. So far, no information system has implemented this feature successfully. For example, one can distinguish a biography from a portrait, a description from a tutorial, a video clip from a specification, and so on (Garshol, 2004). The following figure demonstrates this point succinctly.

File Edit View Favorites Tools Help

Address [http://localhost:8080/omnigator/models/topic\\_complete.jsp?tm=opera.hytm&id=tosca](http://localhost:8080/omnigator/models/topic_complete.jsp?tm=opera.hytm&id=tosca) Go

Google Search Web Search Site PageRank Page Info Up Highlight

# omnigator VI

The free topic map navigator from Ontopia. Powered by the Ontopia Knowledge Suite.

Welcome | Italian Opera | Manage | Customise | Filter | Export | Merge | Statistics | Not indexed | Validate | Query

**Tosca**

current topic

(multiple) types

Type(s): opera

Names (1)

- Tosca

(multiple) names

Metadata (1)

- première
  - 1900 (14 Jan)

Related subjects (25)

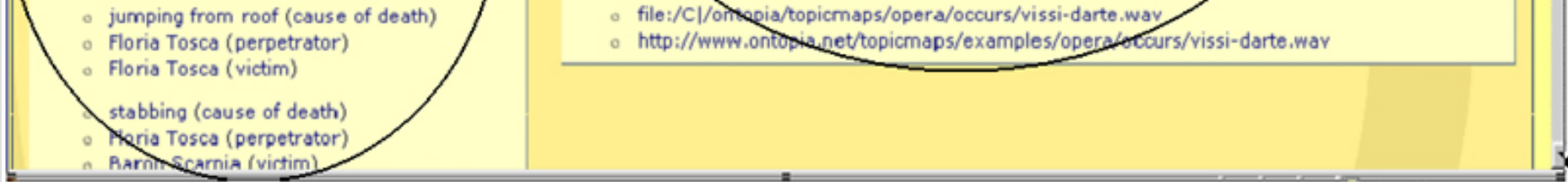
- based on
  - La Tosca
- composed by
  - Puccini, Giacomo
- contains aria
  - O dolci mani
  - Recondita armonia
  - Va, Tosca!
  - Vissi d'arte
  - È lucevan le stelle
- death of character
  - jumping from roof (cause of death)
  - Floria Tosca (perpetrator)
  - Floria Tosca (victim)
  - stabbing (cause of death)
  - Floria Tosca (perpetrator)
  - Barnabè Scarpia (victim)

multiple associations

External resources (8)

- article
  - file:/C:/ontopia/topicmaps/opera/occurs/snl/tosca.htm
  - http://www.ontopia.net/topicmaps/examples/opera/occurs/snl/tosca.htm
- AZ Opera synopsis
  - file:/C:/ontopia/topicmaps/opera/occurs/tosca\_syn.php3.htm
  - http://www.azopera.com/97season/t\_syn.php3
- home page
  - http://opera.stanford.edu/opera/Puccini/Tosca/main.html
- illustration
  - file:/C:/oks-professional/jakarta-tomcat/webapps/omnigator/WEB-INF/topicmaps/occurs/opera/puccini/tosca-poster1.jpg
- libretto
  - file:/C:/ontopia/topicmaps/opera/occurs/tosca-libretto.htm
  - http://opera.stanford.edu/opera/Puccini/Tosca/libretto.html
- Opera News synopsis
  - file:/C:/ontopia/topicmaps/opera/occurs/tosca-synopsis.htm
  - http://www.metopera.org/synopses/tosca.html
- poster
  - file:/C:/ontopia/topicmaps/opera/occurs/tosca\_poster.htm
  - http://www.r-ds.com/opera/pucciniana/pictures/tosca\_poster.htm
- sound clip
  - file:/C:/ontopia/topicmaps/opera/occurs/vissi-darte.wav
  - http://www.ontopia.net/topicmaps/examples/opera/occurs/vissi-darte.wav

multiple occurrences



The above figure shows related information as a map. For example, it shows how 'Tosca' is related to other topics and resources. The right upper section explains that "Tosca" is defined as a type of "Opera." A topic can have various names. A topic can be associated with other topics via topic associations. For example, the topic "Tosca" *is based on* "La Tosca," *is composed by* "Puccini," *contains aria* and is also linked with "death of character" association. If you click a related topic, that topic becomes a new topic and shows related topics and resources. The ability to associate a topic with other topics meaningfully is significant progress.

There are more benefits related to topic maps-based organization. The lower right section shows all resources related to a current topic based on grouping such as articles, AZ Opera synopsis, poster, etc., which are called occurrence type. This makes it possible to define appropriate occurrence types for each domain. This capability makes the second purpose of cataloging achievable. However, to determine what kinds of occurrence types are really useful for the users requires further in-depth studies.

Scope can also be applied to an occurrence to distinguish material suitable for novices from that suitable for intermediate learners. Occurrences use URIs (Uniform Resource Identifier) to identify the information resource being connected to the topic, which means that any kind of information resource from anywhere can be connected to a topic. However, the occurrence does not need to use a URI; the information can also be given a string stored directly in the topic maps. This is useful for attaching simple properties, such as date of birth, phone number, description, etc., to topics.

## **Associations**

Associations show relationships between subjects, and similar to occurrences, they can be assigned types (Garshol, 2004). This allows any kind of relationship to be expressed. Compared to traditional classification schemes, associations have unique features (Garshol, 2004). First of all, there is no longer a hierarchy, but instead there is a network of subjects. Secondly, the relationships

between the subjects are clearly defined, instead of being generic. This is very powerful when conducting searches since it allows queries such as "show me all technologies used with topic maps," or "show me every interchange format based on SGML," and so on. If we can publicly share those relationship descriptions so that others can reuse them, linking relevant information globally will be easier. The effort called "Published Subject Identifier (PSI)" is an attempt to promote topic interoperability by assigning a globally unique ID to each topic with its definition.

## **Web Service and UDDI**

Joss (2004) defined Web service as "an umbrella term for services that take place over the Web, use Internet protocols, and may or may not involve the use of a Web browser" (p.31). The main purpose of Web service is to help people to discover service information wherever they are. Therefore, the focal issue of Web service is how to integrate data from different sources and integrate different modules (Joss, 2004). By integrating applications between and within disparate modules, Web service enhances the efficiency of a company and leads to reduced costs and increased revenues (Lurie & Lurie, 2002).

There have been several trials to apply Web service, especially in the e-business (Kennedy, 2002 & Lurie, 2002). Amazon, Google, and eBay launched Web service to allow users to integrate contents and services into their own websites (Kennedy, 2002). For example, if you highlight any word and right click it, it takes you to Google for a word search (Kennedy, 2002). Concord EFS, Inc. also developed Web Payment Services, which integrates payment processor, business, and payment gateway (Lurie, 2002). The digital library system of the Washington Research Library Consortium (WRCL), called ALADIN, provides a single interface using Web service so that seven academic libraries can use information from this system for their own services (Tennant, 2002).

UDDI, as the part of Web service, is a distributed directory system like the yellow pages of Web services to support the discovery level of Web service (Peek, 2002a). UDDI provides three services – Register, Publish, Search/Browse - to allow service providers to register their companies and services, and other users to find web services and businesses they would like to use. For example, IBM UDDI provides UDDI Business Registry, which aims at supporting B2B e-commerce by allowing businesses to describe their business, services and goods, and discover business partners (Web services by IBM: UDDI). UDDI is served by three-classification schemes - UNSPSC (Universal Standard Products and Services Codes), NAICS (North American Industry Classification System), and ISO 3166.



## **Limitations of UDDI Web Services**

Current UDDI Web services based on three-classification schemes show several limitations for Web services, especially in Korea. First, three-classification schemes are not built for the support of Web service. The purpose of UNSPSC, as an international products and service classification code, is to support resource discovery, expenditure analysis, and product awareness. The purpose of NAICS is to classify US and Canadian industries to support the management of industrial statistic data as well as to classify industries and all their economic activities. The purpose of ISO 3166, as an International Standard for Country Code, is to indicate the names of countries, federations, or regions to keep up with coding needs of related information. This study, conducted to identify how these classification schemes fit into the needs of Web service, shows that these classification schemes are not enough to register and discover business, services, and goods. First of all, there are items that are not appropriate in three classifications for Korea Web Services. One case study of Web services in Korea is a Bank.Net service to support money transfer among banks. However, this service cannot be found in classification schemes in UDDI. The only possible category can be under "Insurance services for structures and property and possessions" of UNSPSC. It is not enough to indicate the service itself. Second, current UDDI registry focuses on the support of B2B e-commerce. UNSPSC is not adequate enough to classify web services, particularly in the area of G2G (Government to Government) or G4C (Government for Citizen). Current classification schemes do not have items to register national defense supply activities or public grievance services, which are kinds of web services developed in Korea.

Based on these previous studies, we developed a Korea web service UDDI classification scheme that can assist users to locate Korea Web services. Specifying the details of that classification scheme is not the focus of this study, but we present the way we improved that classification scheme using topic maps.

## **Lacking in Relationship Expression between Services and Retrieval Problems**

The knowledge organization of current Web services has some limitations. First, current web services use a keyword-based search mechanism, and they return irrelevant resources or miss the user's intention. For example, when a user searches for "security," the UNSPSC search system (a typical keyword-based search engine) returns over 500 results. As shown in Figure 2, it returns any item that has the term "security" in it.

#### Results for security

##### 24.14.15.04.00 Tamper proof or security seals

Segment: Material Handling and Conditioning and Storage Machinery and their Accessories and Supplies  
Family: Packing supplies  
Class: Securing and protecting supplies  
Commodity: Tamper proof or security seals  
Set focus: [Segment](#) || [Family](#) || [Class](#)

##### 25.17.45.01.00 Air bag propellant canisters

Segment: Commercial and Military and Private Vehicles and their Accessories and Components  
Family: Transportation components and systems  
Class: Vehicle safety and security systems  
Commodity: Air bag propellant canisters  
Set focus: [Segment](#) || [Family](#) || [Class](#)

##### 25.17.45.02.00 Air bags

Segment: Commercial and Military and Private Vehicles and their Accessories and Components  
Family: Transportation components and systems  
Class: Vehicle safety and security systems  
Commodity: Air bags  
Set focus: [Segment](#) || [Family](#) || [Class](#)

Second, the current web service does not represent any semantic relationships. As shown in figure 3, the current IBM UDDI system also depends on keyword-based search. When a user searches for "security," it returns all services that have the term "security" in it.

It only displays the service name, description, business owner [parent company] (see Figure 3), and does not provide any relationships or links to other services within security areas so that users could identify other areas that are pertinent to their needs.

## Find Service Results

Your query returned a total of 2 matching service(s). Press the **New Search** button to search again.

Services		
Service Name	Description	Owning Business
<a href="#">Security</a>	Protect against theft.	<a href="#">Test Business 2</a>
<a href="#">Security Prices</a>	<i>None</i>	<a href="#">EMKV</a>

**New Search**

Therefore, in current mechanisms, users have difficulty in locating related information. When users search a system that has a huge number of resources, this problem gets worse. Users have to review lengthy and irrelevant resources and need to spend considerable time in deciding the relevancy of information presented. In addition, this limits the further use of Web services.

### A Case Study of Constructing an Ontology Using Ontopia Tools

#### *Security Domain*

Topic maps might be useful in resolving the limitations of web services raised in this paper. Topic maps can be used as a standard for representation and relationship that is the necessary prerequisite for developing tools that assist in the generation and transfer of knowledge (Ruggles, 1997). All the topics or concepts have relationships or associations and they have either external or internal links.

In order to illustrate topic maps-based UDDI services, we use the Omnigator, a generic application built on top of the Ontopia Navigator Framework that allows users to load and browse topic maps. A screen shot of the interface is shown in figure 4. The page shown is a topic page where “technical security” is the current topic. The topic page shows the related information in the topic map about the current topic.

# omnigator eight

The free Seamless Knowledge browser from Ontopia. Powered by the Ontopia Knowledge Suite.

[Welcome](#) | [Manage](#) | [Customise](#) | [Filter](#) | [Export](#) | [Merge](#) | [Statistics](#) | [Query](#) | [Reload](#) | [Not indexed](#) | [Feedback](#) | [No schema](#)

## OKS Security

### Topic Map Overview

- **Ontology**
- Master Index
- Index of Individuals
- Index of Themes

### Topic Map Metadata

- **Copyright:** The copyright in this topic map is owned by Myongho Yi, and the right to copy or distribute it for any purpose is restricted.
- **Description:** This topic map describes security.
- **Last changed:** \$Date: 2005/06/02 14:49:58 \$
- **Version:** \$Revision: 1.17 \$

### Topic Types (5)

- Commercial Services
- Government Services
- Security Services
- Security Software
- Service

### Association Types (3)

- is part of
- is provided by
- is supervised by

### Association Role Types (6)

- Provided services
- Provider
- Sub-Class
- Super-Class
- Supervised services
- Supervisor

### Occurrence Types (11)

- Address
- Commercial Services
- Copyright
- Description
- Email
- Fax
- Government Services
- Homepage
- Last changed
- Phone
- Version

- 
- Fax
  - Government Services
  - Homepage
  - Last changed
  - Phone
  - Version

All the occurrences of the topic “IBM Security service” are shown on the right, organized by type (see Figure 5). Note that occurrences are displayed in two ways: internal resources (address, phone, fax) and external resource (homepage). Clicking on the homepage address connects the browser to the resource specified.

# omnigator eight

The free Seamless Knowledge browser from Ontopia. Powered by the Ontopia Knowledge Suite.

[Welcome](#) | [OKS Security](#) | [Manage](#) | [Customise](#) | [Filter](#) | [Export](#) | [Merge](#) | [Statistics](#) | [Query](#) | [Reload](#) | [Not indexed](#) | [Feedback](#) | [No schema](#) | [Vizigate](#)

## International Business Machine (IBM) Security Service

Type(s): Industrial Services

### Names (1)

- International Business Machine (IBM) Security Service

### Subject Identifiers (1)

- <http://uci.or.kr/unspsc/topic/IBM>

### Associations (1)

- provides
  - Technical Security

### Internal Occurrences (5)

- Address
  - The Military Mutual Aid Association B/D 467-12 Dogok-dong Gangnam-gu Seoul Korea
- Description
  - IBM provides Access Control Services
- Email
  - [ibmkspe@kr.ibm.com](mailto:ibmkspe@kr.ibm.com)
- Fax
  - (02)3781-7114
- Phone
  - (02)3481-5200

### External Occurrences (1)

- Homepage
  - <http://www.ibm.com>

Object id: 93

Source locator(s):

[file:/C:/Documents%20and%20Settings/Administrator/My%20Documents/My%20Download/oks-navigator-trial-245B14SD.2.0-20050524.tar/oks-navigator-trial/jakarta-tomcat/webapps/omnigator/WEB-INF/topicsaps/security.lta@IBM]

The topic "IBM Security service" is associated with the topic "Technical Security." If users are interested in other providers that offer "technical security," they can just click that association. As shown in Figure 6, four technical security services will be displayed along with providers and a short description about the services. As you can see in this figure, topic maps allow users to see the semantic connections between web services]. In other words, information is not displayed in an isolated manner, but is shown as a kind of concept map. Even though we need a user study to prove whether this kind of display is useful, it appears to be a powerful way to see information in context along with semantic connections to other topics.



## omnigator eight

The free Seamless Knowledge browser from Ontopia. Powered by the Ontopia Knowledge Suite.

Welcome | OKS Security | Manage | Customise | Filter | Export | Merge | Statistics | Query | Reload | Not indexed | Feedback | No schema | Vizigate

### Technical Security

#### Names (1)

- Technical Security

#### Subject Identifiers (1)

- <http://uci.or.kr/unspsc/topic/TechnicalSecurity>

#### Associations (8)

- has parts
  - ◊ Access Control
  - ◊ Application Program Security
  - ◊ Communications Security
  - ◊ Computer Architecture and System Security
- is provided by
  - ◊ Checkpoint Security Service
  - ◊ Computer Associates(CA) Security Service
  - ◊ International Business Machine (IBM) Security Service
  - ◊ PriceWaterHouseCoopers (PWC)Security Service

#### Internal Occurrences (5)

- Description
  - ◊ This service provides a variety of security services.
- Industrial Services
  - ◊ CA - Application Program Security Services
  - ◊ Checkpoint - Communications Security Services
  - ◊ IBM - Access Control Services
  - ◊ PWC - Computer Architecture and System Security

Object id: 33

Source locator(s):

[file:/C:/Documents%20and%20Settings/Administrator/My%20Documents/My%20Download/oks-navigator-trial-245B145D.2.0-20050524.tar/oks-navigator-trial/jakarta-tomcat/weba

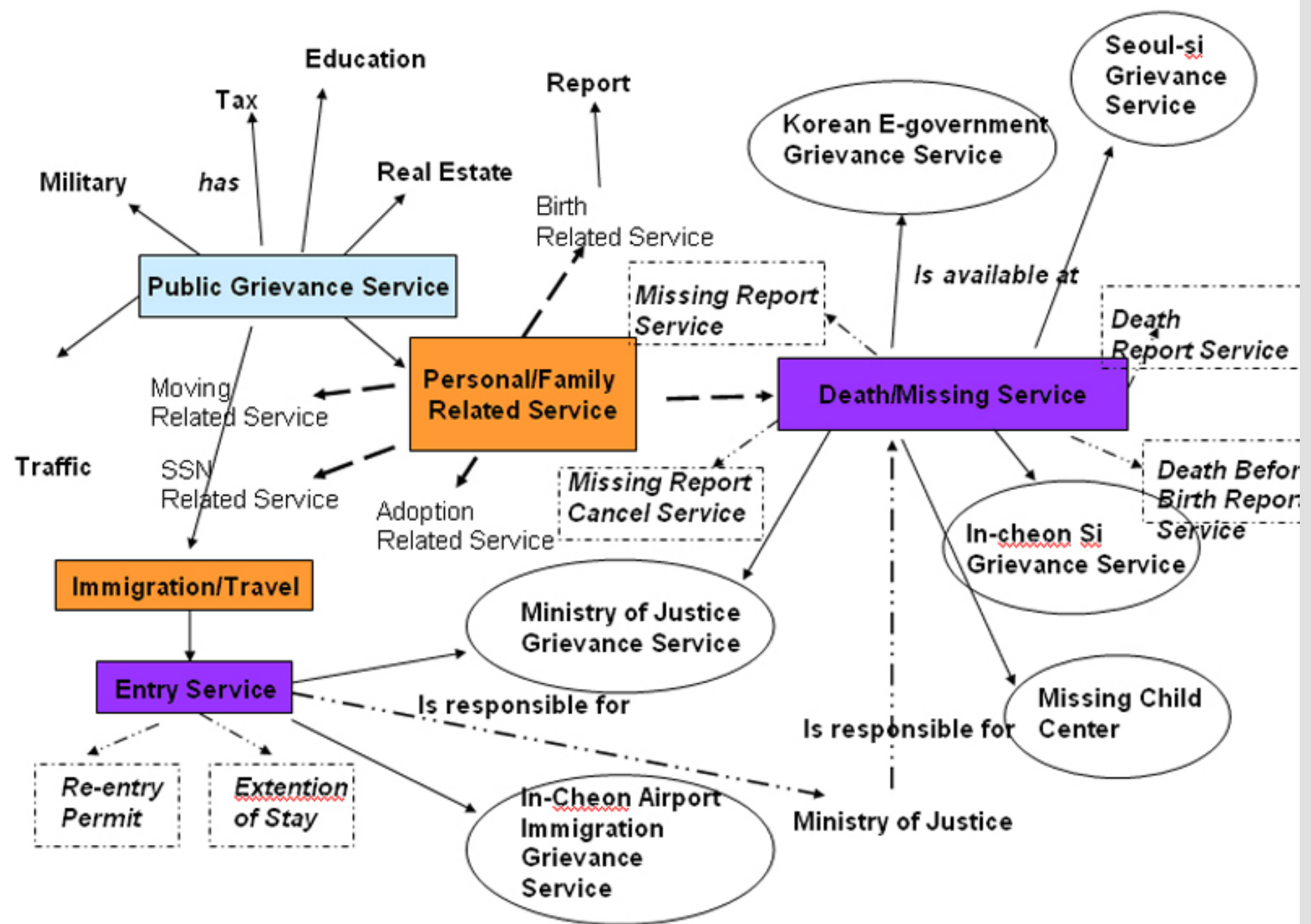
(C) Copyright 2001-2005 Ontopia. All rights reserved. Download the latest version when this one expires!

### Public Grievance Domain

The interest in Web service provided by the government has been increasing in Korea. The Korean government established the Korea Electronic Government Service in 2001 (<http://www.ecif.or.kr/>), of which the Public Grievance Web Service is a main part. Public

grievance web service covers a variety of domains like Taxes, Education, Real Estate, the Military, Traffic, and Personal/Family issues. Within a top domain area, there are many different types of services. For example, "Deceased/Missing Related Grievance Service" supports reporting and locating the death or loss of children. "Military Personnel and Discipline Web Service" supports the reporting discharges from or delayed inductions into military service. Its purpose is to enhance quality of administrative services by developing a one-step service. It seeks to support the use and reuse of information between levels of government, information consisting of many documents held by different departments of government, made available to people with various grievance service needs.

The increased interest in public grievance services in Korea led to the current study. This study reveals many diverse service areas, main functional services and relationships among services, as shown in figure 7. First, it reveals that public grievance service has many levels - public grievance service, personal/family related service, deceased/missing service, the report of missing children service. Second, most grievance services are categorized as different types – application, cancel, permission, and report. Third, government at various levels provide the same service, and [but] a specific government department is responsible for a specific service.



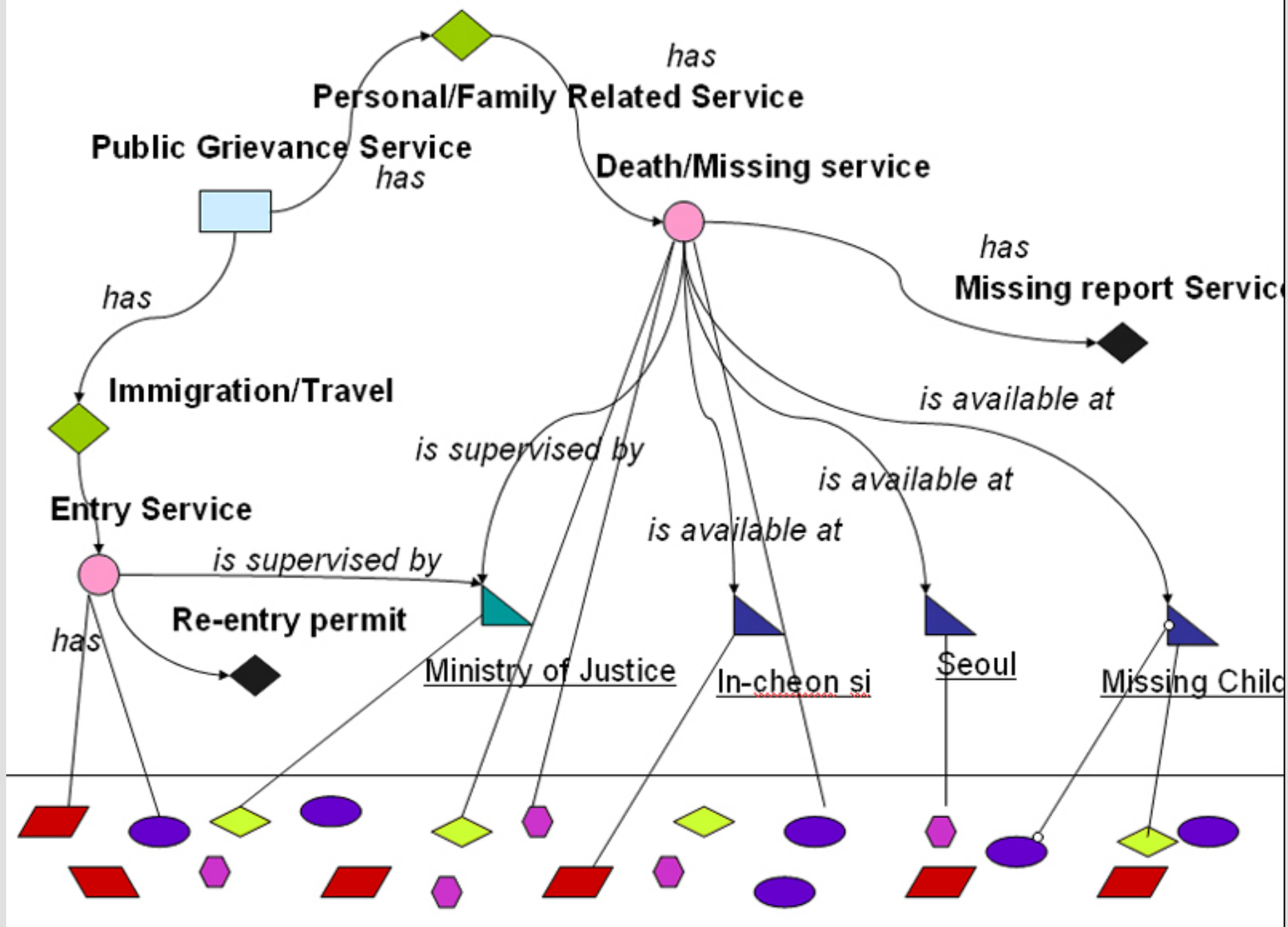
From the study, we found that the main advantages in applying topic maps to the Korea Web service environment is that a search always results in an entry point that is closely related to other topics so that users can explore other relevant information with ease. Providing a search result as a map is a powerful concept and we intend to do further user studies to determine how useful they are in solving users' real needs.

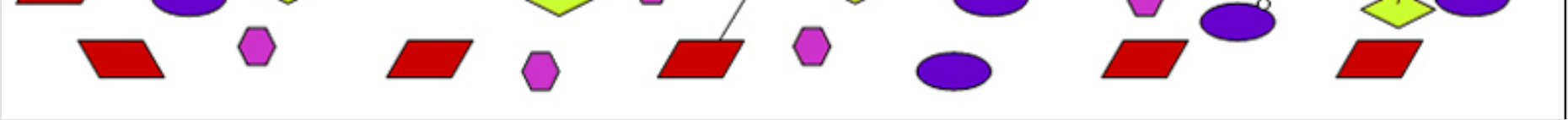
These findings are demonstrated in Figure 8 by a Topic Maps Construct focusing on the Deceased/Missing service.

Topic	Topic Types	Occurrence Type	Association Type
1. Public Grievance 2. Personal/Family Related 3. Immigration/Travel 4. Entry Service [Emigration?] – Entry service needs to keep 5. Deceased/Missing 6. Ministry of Justice	1. Service <ul style="list-style-type: none"> <li>○ Application</li> <li>○ Cancellation</li> <li>○ Permission</li> <li>○ Report</li> </ul>	1.Address 2. Description 3. Email 4. Fax 5. Homepage 6. Location, 7. Phone 8. Federal] Level[Departments] 9. Local Level [Departments] 10. Organization	1.has parts (is part of) 2. provides (is provided by) 3. supervises (is supervised by)
	2.Organization <ul style="list-style-type: none"> <li>○ Central [Federal] Government Level [Departments]</li> <li>○ Local Governmental Level [Departments]</li> <li>○ Other organization</li> </ul>	Occurrence	

[Departments]

- Other organization





As shown in figures 8 and 9, topic maps represent topics, associations, occurrences, and occurrence types. In particular, occurrence types can be any types deemed useful to users, such as “monograph” or “illustration”, “commentary”, and “article”. In this example, deceased/missing services have four different types – description, central division [federal level], local division [local level], and other organization. The Ministry of Justice has address, fax, phone, homepage as occurrence types. However, other occurrence types can be easily added to them. This is demonstrated via Omnigator topic map browser in figure 9.

# The Death/Missing Related Grievance Service

## Names (1)

- The Death/Missing Related Grievance Service

## Associations (10)

- has parts
  - The Death Before Birth Report Service
  - The Death Report Service
  - The Missing Report Cancel Service
  - The Missing Report Service
- is part of
  - The Personal/Family Related Public Grievance Service
- is provided by
  - In-cheon si Grievance Service
  - Korean E-government Grievance Service
  - Seoul-si Grievance Service
  - The Ministry of Justice Grievance Service
- is supervised by
  - The Ministry of Justice Grievance Service

## Subject Identifiers (1)

- <http://uci.or.kr/unspsc/topic/DeathMissing>

## Internal Occurrences (6)

- Description
  - This service provides a variety of public grievance services for the death and the missing.
- Federal Government Level[Departments]
  - Korean E-government - the Death & Missing services
  - The Ministry of Justice - the Death & Missing services
- Local Government Level[Departments]
  - In-cheon si - the Death & Missing services
  - Seoul-si - the Death & Missing services
- Organizaiton
  - MissingChild Center - The Missing Child Finding services

The display by Omnigator shows how the Deceased/Missing Related Grievance Service is represented in relation to other web services in this domain. A user easily can search the "Deceased/Missing Service", and it leads to a concept map for this service: It shows where this service belongs, what kinds of Web services it is related to, where it is being provided, and which governmental division [level/department] supervises, etc. The information is clearly represented not only by showing other related concepts, but also by displaying the relationships between concepts and indicating occurrence and occurrence types. As shown in figure 8, the



death/missing web service displays four occurrence types – central government division, local division, other organization, and description. From here, a user can easily grasp where the death/missing service appears. In figure 9, the Ministry of Justice also displays four occurrence types – Web address, fax, phone, and address.

The Ministry of Justice Grievance Service	
<b>Names (1)</b> <ul style="list-style-type: none"><li>• The Ministry of Justice Grievance Service</li></ul>	<b>Subject Identifiers (1)</b> <ul style="list-style-type: none"><li>• <a href="http://uci.or.kr/unspsc/topic/Minofjustice">http://uci.or.kr/unspsc/topic/Minofjustice</a></li></ul>
<b>Associations (4)</b> <ul style="list-style-type: none"><li>• provides<ul style="list-style-type: none"><li>◦ The Death/Missing Related Grievance Service</li><li>◦ The Entry Related Public Grievance Service</li></ul></li><li>• supervises<ul style="list-style-type: none"><li>◦ The Death/Missing Related Grievance Service</li><li>◦ The Entry Related Public Grievance Service</li></ul></li></ul>	<b>Internal Occurrences (3)</b> <ul style="list-style-type: none"><li>• Address<ul style="list-style-type: none"><li>◦ 88 Kwanmun-Ro Kwa-Cheon si Kyonggi</li></ul></li><li>• Fax<ul style="list-style-type: none"><li>◦ (02)503-7023</li></ul></li><li>• Phone<ul style="list-style-type: none"><li>◦ (02)211-3079</li></ul></li></ul>
	<b>External Occurrences (1)</b> <ul style="list-style-type: none"><li>• Homepage<ul style="list-style-type: none"><li>◦ <a href="http://www.moj.go.kr">http://www.moj.go.kr</a></li></ul></li></ul>

The case study reveals some advantages for Web services. From a user's perspective, one can easily understand the whole picture of a specific service by searching or browsing. A user is able to switch between searching and browsing in a topic map. A significant

strength of topic maps is that a search result of topic map does not provide either links or records, but an entry point into a knowledge map surrounding a particular topic. From the government officials' perspective, they see how a specific service is managed. One central system makes it possible for them to use and reuse information between different levels [departments] to provide users with better grievance service.

Topic maps provide Web service developers with a means to deploy "anywhere-anytime available" systems so that knowledge organization and retrieval might be enhanced. It also makes it easier for Web services to integrate information from many related services and distribute and reuse desirable information.

## **Conclusion and Future Works**

Topic maps-based ontology provides a means to describe rich relationships among Web services. This study shows that ontology-driven knowledge organization based on topic maps provides meaning and structure to data. This way, making related information available in a well-connected manner becomes feasible. Users can therefore search information effectively and efficiently.

Even though there have been many talks on ontology, its potential for information or knowledge management has not been clear. The current study demonstrates how the current UDDI directory service can be significantly improved by means of connecting all the related services in a UDDI directory. Extending and maintaining such a knowledge base using topic maps is very flexible compared to previous attempts. Compared to database design, topic maps allow us to maintain all the relationship types. Current relational implementation of ERD or UML database relationships, rendered as 1:1, 1:M, or M:N only, are very poor, considering the rich information being lost. Topic maps provide means to keep those relationships alive in searching and browsing. This is a very powerful function of topic maps. In addition, if we begin to share topics, associations, and occurrence types with others using PSI (Published Subject Identifier), the power of ontology interoperability will be all the greater.

There have been many debates and arguments about whether topic maps or RDF is a better ontology language. On the other hand, W3C and ISO set up a task force to make these two standards interoperable. The Semantic Web Best Practices and Deployment

(SWBPD) Working Group supports the RDF/Topic Maps Interoperability Task Force (RDFTM) to help users who want to combine data from W3C RDF/OWL and ISO Topic Maps. From now on, interoperability between RDF and topic maps will be much easier.

For future study, it will be necessary to conduct user studies to evaluate how topic maps such as occurrence types or association types are more useful in solving users' real needs. To do this research, we may need to build a sizable database using topic maps so that real queries can be tested.

Another useful study would be to compare the benefits of having information in a connected manner with having it in a dispersed manner. Topic maps-based knowledge organization provides the former, and keyword-based searching belongs to the latter.

We believe that topic maps have many promising features from which researchers in knowledge organization and representation will benefit. In conclusion, RDF/OWL is suitable for situations that require strong inferencing capability from a knowledge base, but topic maps will be very useful in situations that require intelligent connection of related information.

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